RFL Communications plc

SMX3 / 40 Sub-MUX

X21 High speed sub-rate multiplexer

User Manual

Issue 2.02

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Issue	Comments	Date
1.00c	Final Draft issue.	24 May 2006
1.01a	Released with prototype for site trials.	21 June 2006
1.02	Requirement for all links to be connected to network master clock removed. Output timing signal onto X21 link added to enable link synchronisation. Example configurations added.	01 Aug 2006
1.03	Connections to Westica Radio amended	04 Aug 2006
2.00	Revised on release of units Serial. No 10 - 79. (Backward compatible to earlier versions). Channels redefined as A, B, C, D	07 December 2006
2.01	Example Configuration 5 amended and Configuration 6 added. Minor clarifications. Applicable Firmware release smx-0-5.mcs	26 March 2007
2.02	Alarm connections table corrected.	07 May 2009

1. Introduction

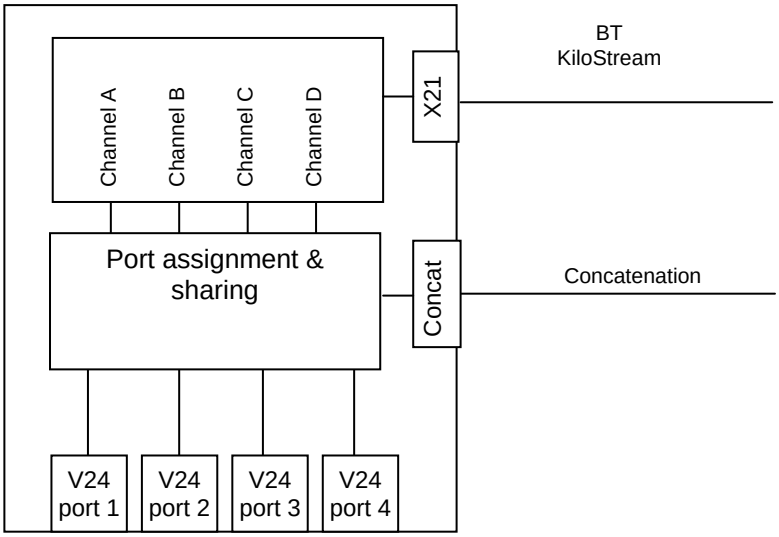
Power utilities have historically used RFL9850 voice frequency modems for teleprotection and SCADA communications. Separate frequency bands within the available spectrum provide two channels over single private circuits rented from BT or other telcos. Historically these rented circuits have been analogue circuits from end to end, but BT, for example, are now in the process of converting the central sections of some of these circuits to digital.

It has been found that where digital elements have been introduced into these circuits, although there is no significant degradation in the character format of the serial data conveyed, the introduction by BT of analogue to digital converters has introduced additional end-to-end delays. This may affect performance; for example, some types of circuit protection relay (e.g. the MPR - LZPK102 relay) time their transmissions from the zero crossing of the protected circuit. The receiving relay expects the start of the received message to be within a certain period of its own measured zero crossing. Thus the introduction of additional transmission delays associated with analogue to digital converters causes errors to be recorded.

The RFL digital Sub-MUX SMX3/40 enables up to four V24 (typically RS232) data channels to share a single X21 digital communications link, (e.g. BT Kilostream, microwave), eliminating the delays introduced by analogue to digital converters. User interfaces are compatible with standard industrial formats enabling the SMX3/40 to be used in many applications that require legacy equipment to operate over current X21 communication links.

2. Features

The RFL SMX3/40 Sub-MUX is a hardened (EATS 48-5) sub-rate multiplexer. The equipment is 19" rack mountable, 1U high, with reversible mounting brackets permitting either the connectors or the LEDs to face the front of the rack.



SMX3 / 40 Block Diagram

SMX3/40 aggregates four V24 data channels (channel A – channel D, typically used for RS232 communications) across a single point to point X21 service. These channels may be defined in terms of their characteristics, or maybe selected to 'transparent' mode offering minimal delay at speeds up to 2400 baud, particularly suited to delay sensitive protection relays. Up to four channels of data or protection can be run over a single X21 link within the performance of the equipment.

Four V24 ports, (port 1 – port 4), are provided. These may be configured to any channel, with up to all four ports being allocated to one channel if required. This feature is useful for supporting SCADA systems where multiple terminals are attached.

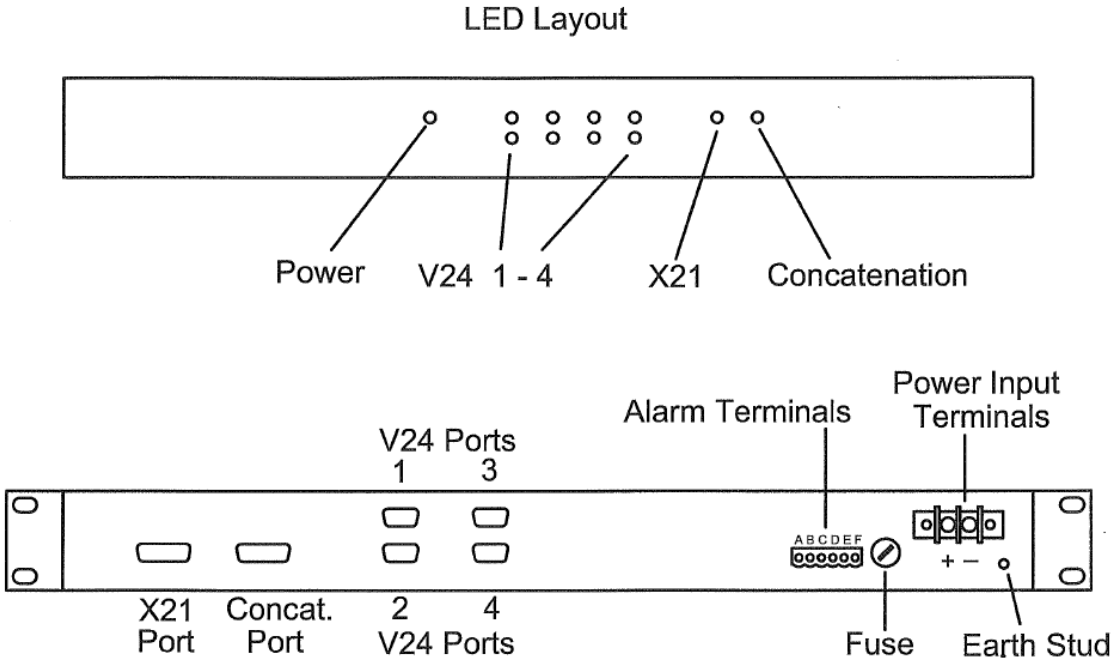
Status LEDs are provided for power supply healthy, V24 ports, X21 Port and Concatenation Port. Two volt free alarm changeover contacts are provided for power and aggregate communications healthy.

3. Concatenation and Network Timing

SMX3/40 will operate on a network of concatenated X21 links. A facility is provided so that two co-located SMX3/40 (i.e. one at each end of separate X21 links) units can be linked 'back to back'. This feature is referred to as Aggregate Concatenation. In this case the units may be configured so that the data on one or more channels is re-transmitted onto a second point to point link at the aggregate level. For this to operate all links must be synchronised to the network master timing signal. If any link within the network is unsynchronised (e.g. a single radio link), SMX3/40 provides the option to output master network clock signals to otherwise unsynchronised links.

An alternative option is to concatenate a single data channel at V24 level by daisy-chaining the V24 data links. This is referred to as Data Channel Concatenation. In this case each X21 link may be free-running (unsynchronised).

4. Equipment Layout



5. Channel Characteristics

SMX3/40 aggregates four point to point bi-directional V24 data channels across a single X21 service (64 kbits/s)

Channels A, B and C sample at 16kbits/s
Channel D samples at 8kbits/s

DIP switch settings permit each V24 port to be allocated to any channel. Additionally each V24 data channel may be selected to either 'Transparent' mode or one of two 'Async' modes.

Transparent mode uses a **minimal delay protocol** for applications where end-to-end delay is critical (eg MPR LZPK102 protection relays operating at 600 baud). It may also be used for applications where asynchronous character formats are not specifically supported. See table for maximum supported baud rates.

In Async mode (8-bit or 9-bit characters) the channel baud rates may be set within the range shown in the table to match the connected equipment.

V24 Channel	A	B	C	D
Sampling Rate (64kbits/s aggregate) kbits/s	16			8
Transparent mode – max baud rate supported	2400			1200
Async mode – baud rates supported	1200 - 9600			1200 - 4800

6. Performance

When two SMX3/40 sub-MUXs are interconnected on a direct 64kbit/s X21 link, the following maximum delays will be achieved for a V24 channel set to Transparent mode:

V24 Channel in Transparent mode	A	B	C	D
Max delay ms	0.5			1

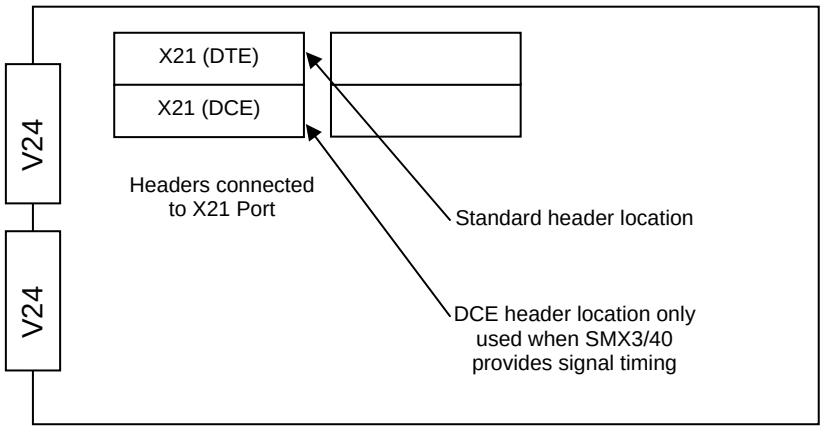
When used for interconnecting MPR LZPK102 relays, the end-to end transmission delay on the circuit is required to be less than 5ms. The delay introduced by the BT X21 link is unknown. (BT SIN355 specifies a max. delay of 1.25ms for an *Analogue* Standard data circuit between 1000 and 2600Hz. For digital circuits SIN355 states "With the advent of the wholly digital BT core network, relative group delay has become less of a significant parameter in relation to the transmission of voiceband data"). If it is assumed that transmission delay within the BT element will not exceed 2.5ms, using SMX3/40 in transparent mode enables total end to end transmission times in the order of 3 to 3.5ms to be achieved, depending on the channel used.

7. X21 port

The X21 port is a DB15 male connector; this is connected internally to a header on the PCB using a ribbon cable. The X21 port may be configured as DTE or DCE by fitting the ribbon cable to the appropriate X21 Port Header, and by selecting settings on DIP switch 5. **Note: DTE is the standard configuration, and is used in all applications where the network provides the signal timing.**

Transceivers are specified to ± 15kV IEC1000-4-2 air discharge ESD protection and port connections are additionally protected by Tranzorb type arrays.

This port carries an aggregate of four bi-directional data channels, channels 0 to 2 sampling at 16kbits/s and channel 3 at 8kbits/s on a 64kbits/s service. A bi-directional control signal is also provided for each data channel.



X21 header locations

Standard X21 Port Pin-out (when in DTE configuration) – D15M					
Circuit		**Pin A**	**Pin B**	**Direction**	**Notes**
T	Transmit Data	2	9	Output	
R	Receive Data	4	11	Input	
C	Control	3	10	Output	Permanently on
I	Indication	5	12	Input	Signal ignored
S	Signal Element Timing	6	13	Input	Timing signal received from network
G	Ground	8	15		
X	Signal Element Timing	7	14	Output	Timing signal transmitted to network (X). Special applications only. Requires to be enabled using mode DTE + Timing X enabled
	Screen / Drain				**Must be earthed to shell**

Optional X21 Port Pin-out (when in DCE configuration) – D15M					
Circuit		**Pin A**	**Pin B**	**Direction**	**Notes**
T	Transmit Data	2	9	Input	
R	Receive Data	4	11	Output	
C	Control	3	10	Input	Signal ignored
I	Indication	5	12	Output	Permanently on
S	Signal Element Timing	6	13	Output	Timing signal transmitted to network
G	Ground	8	15		
	Screen / Drain				**Must be earthed to shell**

In either configuration, use 6 pair plus ground stranded cable with overall shield (eg RS 111-8994).
Maximum recommended length in substations - 5m
Absolute maximum length - 10m.

The DCE configuration is used when the X21 link requires to be synchronised to the network master clock signal that has been received from a co-located SMX3/40, or to itself as master where network timing is unavailable. The timing signal is output on pins 6 and 13.

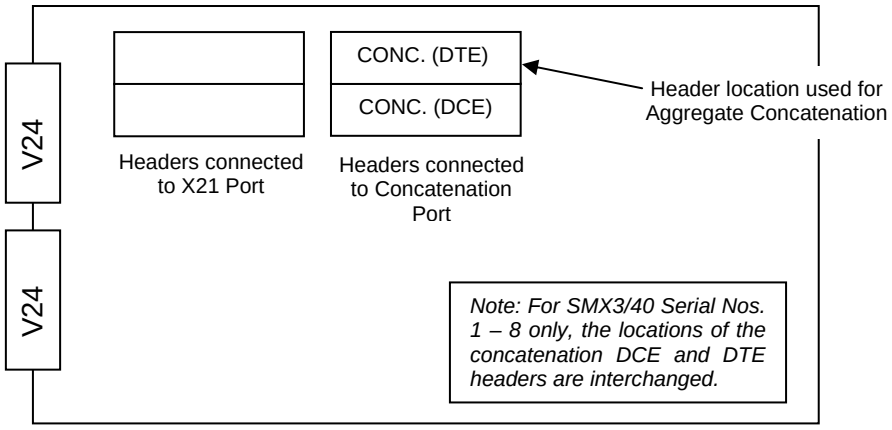
DIP switches provide configuration options, see section 10.

8. Concatenation Port

The Concatenation Port provides optional direct connection to a co-located SMX3/40 serving another X21 link. Unless interrupted by a particular V24 port setting, aggregate channel data passes between this port and the X21 port. This port has the same capacity as the X21 Port. Signal timing is always transferred across the Concatenation port when the port mode is set to 'Aggregate Concatenation'.

The Concatenation Port is a DB15 female connector; this is connected internally to a header on the PCB using a ribbon cable. The Concatenation Port may be configured as DTE or DCE by fitting the ribbon cable to the appropriate X21 Port Header, and by selecting settings on DIP switch 5. **Note: DTE is the standard header location used for Aggregate Concatenation i.e. direct connection to a co-located SMX3/40.**

Transceivers are specified to ± 15kV IEC1000-4-2 air discharge ESD protection and port connections are additionally protected by Tranzorb type arrays.


V24
V24
CONC. (DTE)
CONC. (DCE)
Header location used for Aggregate Concatenation
Headers connected to X21 Port
Headers connected to Concatenation Port
Note: For SMX3/40 Serial Nos. 1 – 8 only, the locations of the concatenation DCE and DTE headers are interchanged.

Concatenation header locations

Standard Concatenation Port Pin-out (when in DTE configuration), as used for Aggregate Concatenation - D15F					
Circuit		**Pin A**	**Pin B**	**Direction**	**Notes**
T	Transmit Data	2	9	Output	
R	Receive Data	4	11	Input	
S	Signal Element Timing	6	13	Input	Timing signal received from network
G	Ground	8	15		
X	Signal Element Timing	7	14	Output	Timing signal transmitted to network. Used for Aggregate Concatenation facility; requires mode DTE + Timing Signal X enabled
C	Control	3	10	Output	Permanently on. Not used in Aggregate Concatenation
I	Indication	5	12	Input	Signal ignored. Not used in Aggregate Concatenation
	Screen / Drain				**Must be earthed to shell**

Optional Concatenation Port Pin-out (when in DCE configuration) – D15F					
Circuit		**Pin A**	**Pin B**	**Direction**	**Notes**
T	Transmit Data	2	9	Input	
R	Receive Data	4	11	Output	
C	Control	3	10	Input	Signal ignored
I	Indication	5	12	Output	Permanently on
S	Signal Element Timing	6	13	Output	Timing signal transmitted to network
G	Ground	8	15		
	Screen / Drain				**Must be earthed to shell**

Aggregate Concatenation

Aggregate Concatenation is the interconnection at ***aggregate*** level of two co-located SMX3/40 units. In this mode the Concatenation Port is enabled as DTE with Timing X enabled. The timing signal is then transmitted on pins 7 and 14 (Xa and Xb).

Aggregate Concatenation to a co-located SMX3/40 requires a five twisted pair cross-over cable of, pins A to A and B to B:

Aggregate Concatenation Cable D15M – D15M			
Pair	**Pin**	**End A**	**End B**
1	A	2	4
	B	9	11
2	A	4	2
	B	11	9
3	A	6	7
	B	13	14
4	A	7	6
	B	14	13
5	A	8	8
	B	15	15
Screen / Drain		**Must be earthed to connector shells at both ends**	

Use 5 pair plus ground stranded cable with overall shield (eg RS 111-8988).
Maximum recommended length 5m; absolute maximum 10m.

DIP switches provide configuration options, see section 10.

9. V24 ports

Four DCE ports are provided on DB9 female connectors for asynchronous data:

Circuit		**Pin**	**Direction**
TxD	Transmit Data	3	Input
RxD	Receive Data	2	Output
RTS	Request to Send	7	Input
CTS	Clear to Send	8	Output
DCD	Data Carrier Detect	1	Output
DTR	Data Terminal Ready	4	Input
DSR	Data Set Ready	6	Output
RI	Ring Indicator	9	Output
SG	Signal Ground	5	
Screen / Drain must be connected to the connector Shell			

RI is permanently OFF.
DSR is ON when aggregate framing is synchronised.
DTR is ignored.
RTS turns on remote DCD and local CTS after a delay.

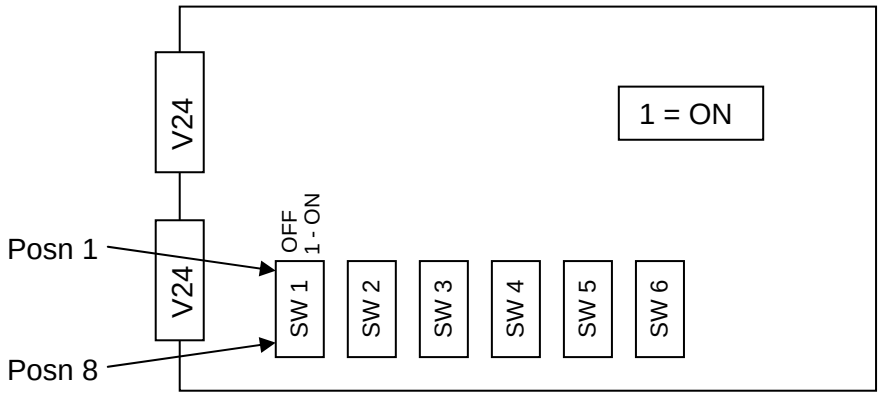
Transceivers are specified to ± 15kV IEC1000-4-2 air discharge ESD protection and port connections are additionally protected by Tranzorb type arrays.

DIP switches provide configure options for each port, see section 10.

Data Channel Concatenation

SMX3/40 units co-located at one end of adjacent unsynchronised links may be concatenated at the V24 level either through the connected equipment, or directly using a crossed RS232 data cable.

10. DIP switches



DIP Switch Locations

Switches 1 to 4 correspond to V24 ports 1 to 4

Switch 5 controls enabling of X21 port and Concatenation port, and provides some test functions.

Switch 6 sets V24 RTS timeout, Timing source and Aggregate speed

Setting data is on the following pages.
Refer to Section 14 for example configurations.

DIP Switch 1 – 4 settings:
Switches 1 to 4 correspond to V24 ports 1 to 4

8	7	6	5	4	3	2	1
Baud Rate		Aggregate Direction		Mode		Channel Allocation and Sharing	
00 = 1200		00 = X21 Port		00 = Disabled		00 = Ch A	
01 = 2400		01 = Concat. Port		01 = Transparent		01 = Ch B	
10 = 4800		10 = Both Ports		10 = Async 8 bit		10 = Ch C	
11 = 9600		11 = Local Loop		11 = Async 9 bit		11 = Ch D	

- Channel Allocation and Sharing: Select aggregate channel A, B, C, D

  Each port can be allocated to any channel. More than one port may share a channel. Where more than one port is allocated to the same channel, the ports share the channel. From the point of view of one of those ports, Transmit Data would be sent over the aggregate channel and to all other ports allocated to the same channel. Data from the aggregate channel or other such port(s) would appear as Received Data. This feature is useful for supporting SCADA systems where multiple terminals are attached, but they must be well disciplined where only one terminal transmits at once, waiting for CTS after asserting RTS.

- Mode: Disabled, Transparent, Async 8 bit, Async 9 bit.

  Transparent is used where end-to-end delay is critical and may also be used for applications where asynchronous character formats are not specifically supported. The baud rate settings are ignored. (See section 5)

  Async 8 bit is selected for: 7 data bits plus 1 parity bit (even or odd).
  or: 8 data bits plus 0 parity bit.
  Async 9 bit is selected for: 8 data bits plus 1 parity bit (even or odd).

- Aggregate Direction: X21 Port, Concatenation Port, Both Ports.

  If X21 Port is selected, traffic on the allocated aggregate channel terminates at this port. That channel is then available for other traffic over the Concatenation Port.

  If Concatenation Port is selected, data on the selected aggregate channel terminates at this port and that channel is available for other data over the X21 Port. Referring to Example 4 in Section 14: Data on aggregate channel B terminates at B2.

  If Both is selected, traffic on the selected aggregate channel between X21 Port and Concatenation Port appears at RxD as an 'or' of data from either direction, and TxD is sent in both directions. As with port sharing described in Aggregate channel allocation above, this mode is suitable only for a well-disciplined system (where only one terminal transmits at once), waiting for CTS after asserting RTS.

- Baud Rate: 1200, 2400, 4800, 9600 bits/sec.

  When Async 8 or Async 9 mode is selected, set the baud rate to match the connected equipment. 9600 bits/s requires allocation to a 16kHz sampling channel (ie channels A, B or C).

  Do not set different baud rates for ports allocated to the same aggregate channel.

DIP Switch 5 settings:
Switch 5 controls enabling of X21 port and Concatenation port, and provides some test conditions for factory use only.

<table>
<tr><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td colspan="4">Concatenation Port</td><td colspan="4">X21 Port</td></tr>
<tr><td rowspan="5">Local Loop
0 = Off
(1 = On
Test use only)</td><td rowspan="5">0
Spare</td><td colspan="2">Mode</td><td rowspan="5">Local Loop
0 = Off
(1 = On
Test use only)</td><td rowspan="5">0
Spare</td><td colspan="2">Mode</td></tr>
<tr><td colspan="2">00 = Disabled</td><td colspan="2">00 = Disabled</td></tr>
<tr><td colspan="2">01 = Enabled as DTE</td><td colspan="2">01 = Enabled as DTE</td></tr>
<tr><td colspan="2">10 = Enabled as DCE</td><td colspan="2">10 = Enabled as DCE</td></tr>
<tr><td colspan="2">11 = Aggregate Concatenation i.e. Enabled as DTE + Timing Signal X</td><td colspan="2">11 = Enabled as DTE + Timing Signal X</td></tr>
</table>

- Mode: Disabled, Enabled as DTE, Enabled as DCE, Enabled as DTE + Timing Signal X

  Enabled as DTE. This is the normal setting for the X21 Port when connecting to X21 links carrying network master clock timing (eg BT Kilostream)

  Enabled as DCE. This optional setting is used when the X21 link requires to be synchronised to the network master clock signal received from a co-located SMX3/40, (or to itself as master where network timing is unavailable). The timing signal X is output on pins 6 and 13 (Sa and Sb). Refer to Section 14 Example 3

  Enabled as DTE + Timing X. This is the normal setting for the Concatenation Port when connecting to a co-located SMX3/40 using the Aggregate Concatenation facility. The timing signal X is output on pins 7 and 14 (Xa and Xb).

- Local Loop: ON / OFF

  Normally set to Off.
  When On: data on TxD is returned on RxD, RTS is returned on CTS and DCD.

DIP Switch 6 settings: Switch 6 sets V24 RTS timeout, Timing source and Aggregate speed

8	7	6	5	4	3	2	1
Aggregate Speed kbits/s		Timing Source		Port 4	Port 3	Port 2	Port 1
00 = 64		00 = X21 Port		V24 RTS timeout 1 = enable			
10 = 128		01 = Concat Port					
01 = 192		10 = Master					
11 = 256		11 = Auto					

- V24 Port RTS Timeout:

  Normally set to Enabled for a polling system.
  When Enabled, the effect of RTS ON is limited to 2 seconds, i.e. CTS and remote DCD turn OFF and TxD is blocked. In order to recover, RTS presented to the port has to turn off and remain off for 2 seconds. This feature is to prevent a faulty RTU of a SCADA system from interfering with traffic on the rest of the SCADA system.

  Do not set to Enabled when port is dedicated for use with MPR or other protection relay, or when testing with a data tester.

- Timing source: X21 Port, Concatenation Port, Master, Auto,

  X21 is the normal setting for applications where the SMX3/40 X21 port is connected to a service synchronised with the network master clock.

  Concatenation Port is the setting used when an X21 link needs to be synchronised to the network master clock signal from an **adjacent** link. Signal timing is via the concatenation port from the co-located unit. When used in conjunction with the modes Enabled as DCE, (or Enabled as DTE + Signal Timing X), the timing signal received from the concatenation port will be output onto the X21port.

  Master is used where two units are interconnected via concatenation ports and the X21 service is unavailable. The clock is generated internally and transmitted on X. It is used with modes Enabled as DCE, (or Enabled as DTE + Signal Timing X); the timing signal generated internally will be output onto the X21port. This would generally be used as a test function.

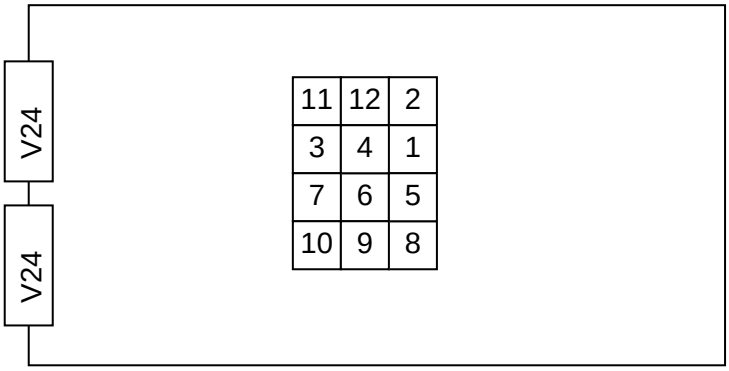
  Auto locks timing to the X21 port as a priority and to the Concatenation port if that fails. When timing is locked to the Concatenation port and an acceptable clock appears on the X21 port, timing source will revert to the X21 port. This function has a special application for East-West applications where both X21 and Concatenation ports receive network master clock timing. This is not used when concatenating consecutive point to point links using the concatenation port to connect to an co-located SMX3/40.

- Aggregate Speed: 64, 126, 192, 256 kbits/s

  Set to match the network clock speed. For X21 networks operating at n = 1, set to 64kbits/s.

11. LEDs

12 LEDs are located in the centre of the board for connection via flexible light pipes to display locations. See equipment layout.



LED	Colour	Function
1	Green	Power input 1
2	Green	Power input 2 (only where applicable)
3	Green	V24 Port 1 Transmitting data
4	Green	V24 Port 1 Receiving data
5	Green	V24 Port 2 Transmitting data
6	Green	V24 Port 2 Receiving data
7	Green	V24 Port 3 Transmitting data
8	Green	V24 Port 3 Receiving data
9	Green	V24 Port 4 Transmitting data
10	Green	V24 Port 4 Receiving data
11	Red/Green	X21 port – see following table
12	Red/Green	Concatenation port – see following table

LEDs 11 & 12 illuminate according to SMX3/40 and Aggregate status on the associated port. When communications are healthy, the LED should be solid green for an enabled port.

X21 and Concatenation LED status	
Display	**Condition**
Off	Port disabled
Fast flash (3/s)	Configuration error
Slow flash (1/s)	No clock present
Steady	Bit timing locked to Master Clock - Healthy
Red	Aggregate frame not synchronised
Green	Aggregate frame synchronised - Healthy
Yellow	Yellow alarm (remote alarm)

12. Power Input

Power input is 48 Vdc nominal. (24V – 72V range).
SMX3/40 can be connected to positive earth, negative earth or floating supplies.

The power connections P1 and P2 are not polarity sensitive, but when using a grounded supply, the 0V leg must be connected to P2. (See table)
A 500mA fuse (5 x 20mm) is in the rail connected to the P1 terminal.

A separate earth connection is required to the M4 Earth stud provided.

Power Input Connections			
Type of supply	Terminal P1	Terminal P2	Earth stud
Positive Earth	– 48Vdc	0V	Main Earth
Negative Earth	+48Vdc	0V	Main Earth
Floating	Either	Either	Main Earth

13. Alarms

Two alarm relays are incorporated, energised when healthy. Each relay provides a single changeover contact presented on a plug-in terminal strip, see equipment layout. For a contact that closes on alarm, use common and NC connections.

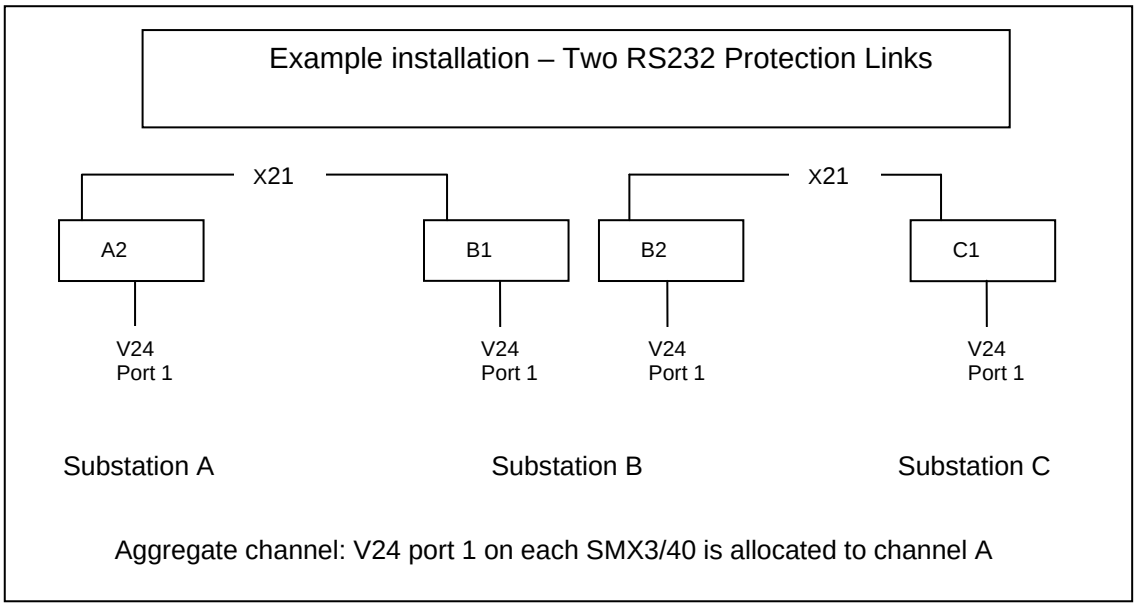
- Power alarm:
  Energised when healthy
  Alarm state is when applied voltage falls below nominal minimum voltage.

- Aggregate communications alarm:
  Alarm state is when any of the following conditions are present on either the X.21 or Concatenation ports (only when enabled):
  Aggregate port configuration error
  No clock present
  Aggregate frame not synchronised
  Yellow alarm (remote alarm)

Alarm Connections			
Function	Terminal	Contact	Notes
Aggregate Comms Alarm	A	NC	Closed in alarm state
	B	Common	
	C	NO	Closed when healthy
Power Alarm	D	NC	Closed in alarm state
	E	Common	
	F	NO	Closed when healthy

14. Example Configurations

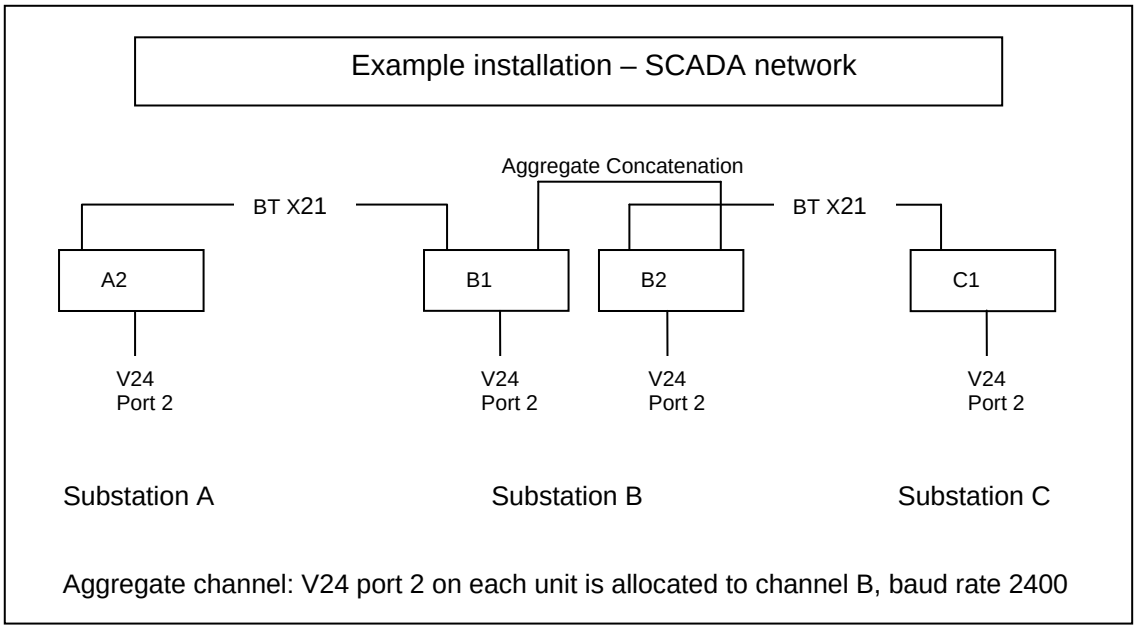
Example 1: Point to point: asynchronous data: minimal delay (eg protection relays):
Set Aggregate Direction for A2, B1, B2 and C1 all to X21 port. Data from B1 will communicate to A2 on aggregate channel A; separate data will be communicated from B2 to C1 using the same aggregate channel. This configuration assumes a master clock signal is provided by the X21 links.



DIP Switch Settings for all units								
	8	7	6	5	4	3	2	1
SW1	0	0	0	0	0	1	0	0
SW2	*	*	*	*	*	*	*	*
SW3	*	*	*	*	*	*	*	*
SW4	*	*	*	*	*	*	*	*
SW5	0	0	0	0	0	0	0	1
SW6	0	0	0	0	*	*	*	0

* indicates setting not applicable to this setup

Example 2: Aggregate Concatenation with synchronised links (e.g. SCADA network on two BT kilostream X21 links):
Set Aggregate Direction for A2 and C1 to X21 port, and for B1 and B2 to Both ports. Transmit and Receive data is presented at all ports. Only possible on a well disciplined system, where only one terminal transmits at once. This configuration assumes that both X21 links are running on the same network master clock e.g. BT Kilostream.



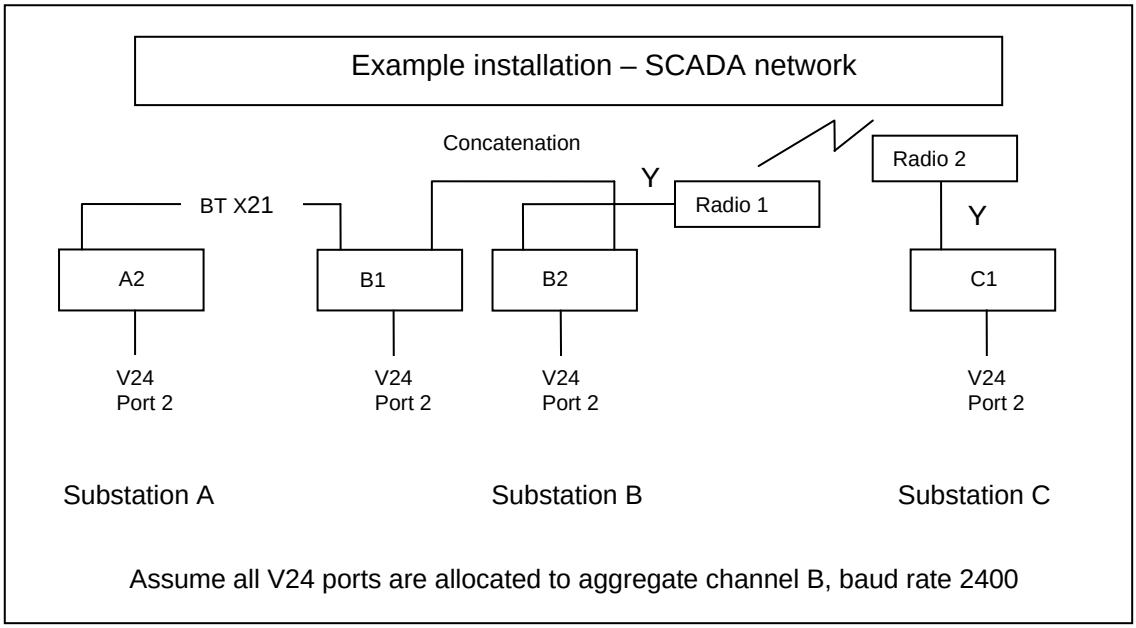
DIP Switch Settings for units A2, C1								
	8	7	6	5	4	3	2	1
SW1	*	*	*	*	*	*	*	*
SW2	0	1	0	0	1	0	0	1
SW3	*	*	*	*	*	*	*	*
SW4	*	*	*	*	*	*	*	*
SW5	0	0	0	0	0	0	0	1
SW6	0	0	0	0	*	*	1	*

* indicates setting not applicable to this setup

DIP Switch Settings for units B1, B2								
	8	7	6	5	4	3	2	1
SW1	*	*	*	*	*	*	*	*
SW2	0	1	1	0	1	0	0	1
SW3	*	*	*	*	*	*	*	*
SW4	*	*	*	*	*	*	*	*
SW5	0	0	1	1	0	0	0	1
SW6	0	0	0	0	*	*	1	*

* indicates setting not applicable to this setup

Example 3: Concatenated links with one link connected to network master clock and the second link synchronised to it, e.g. radio link:
Set Aggregate Direction for A2 and C1 to X21 port, and for B1 and B2 to Both ports. Transmit and Receive data is presented at all ports. Only possible on a well disciplined system where only one terminal transmits at once. This configuration illustrates the network master clock sourced from the BT Kilostream link.



The timing on the radio link is synchronised with the master clock on the BT link by configuring the SMX3/40 at B2 as DCE on the X21. This will output timing onto the B2 – C1 link. B2 is the source of the timing signal for this link which is received from B1 over the concatenation link. The SMX3/40 at C1 is not configured to output signal timing on the X21 link.

Where Westica radios are deployed, these are configured as detailed in section 7.6 Figure 7-2 of the Westica manual. Radio 1 (B2 end) is to be configured as Ext Master DTE, Radio 2 at C1 end is configured as Slave (DCE)
Cables Y are standard X21 'straight' cables as following table.

SMX3/40 – Westica Connection cable – straight X21 (Cable Y)			
SMX3/40 X21 (DCE) D15 pin-out		Radio D37 pin-out	
Note: Fit ribbon to X21 DCE header			
Connection	Pin	Connection	Pin
Txa	2	Txa	2
Txb	9	Txb	20
Rxa	4	Rxa	4
Rxb	11	Rxb	22
Ca	3	Ca	3
Cb	10	Cb	21
Ia	5	Ia	5
Ib	12	Ib	23
Sa	6	Sa	6
Sb	13	Sb	24
G	8		
Screen grounded to shell		Screen grounded to shell	

DIP Switch Settings for A2								
	8	7	6	5	4	3	2	1
SW1	*	*	*	*	*	*	*	*
SW2	0	1	0	0	1	0	0	1
SW3	*	*	*	*	*	*	*	*
SW4	*	*	*	*	*	*	*	*
SW5	0	0	0	0	0	0	0	1
SW6	0	0	0	0	*	*	1	*

* indicates setting not applicable to this setup

DIP Switch Settings for B1								
	8	7	6	5	4	3	2	1
SW1	*	*	*	*	*	*	*	*
SW2	0	1	1	0	1	0	0	1
SW3	*	*	*	*	*	*	*	*
SW4	*	*	*	*	*	*	*	*
SW5	0	0	1	1	0	0	0	1
SW6	0	0	0	0	*	*	1	*

* indicates setting not applicable to this setup

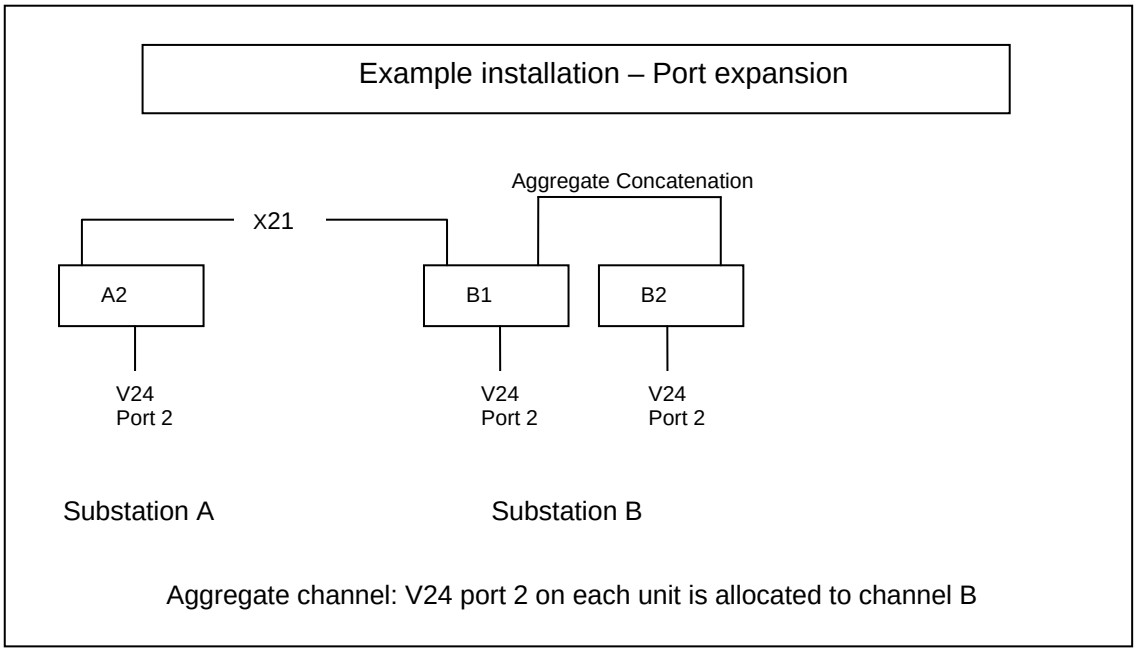
DIP Switch Settings for B2								
	8	7	6	5	4	3	2	1
SW1	*	*	*	*	*	*	*	*
SW2	0	1	1	0	1	0	0	1
SW3	*	*	*	*	*	*	*	*
SW4	*	*	*	*	*	*	*	*
SW5	0	0	1	1	0	0	1	0
SW6	0	0	0	1	*	*	1	*

* indicates setting not applicable to this setup

DIP Switch Settings for C1								
	8	7	6	5	4	3	2	1
SW1	*	*	*	*	*	*	*	*
SW2	0	1	0	0	1	0	0	1
SW3	*	*	*	*	*	*	*	*
SW4	*	*	*	*	*	*	*	*
SW5	0	0	0	0	0	0	0	1
SW6	0	0	0	0	*	*	1	*

* indicates setting not applicable to this setup

Example 4: Port expansion:
Set Aggregate Direction for A2 and B1 to X21 port, and for B2 to Concatenation port. Transmit and Receive data is presented at all ports, but terminates at B2. Only possible on a well disciplined system where only one terminal transmits at once.



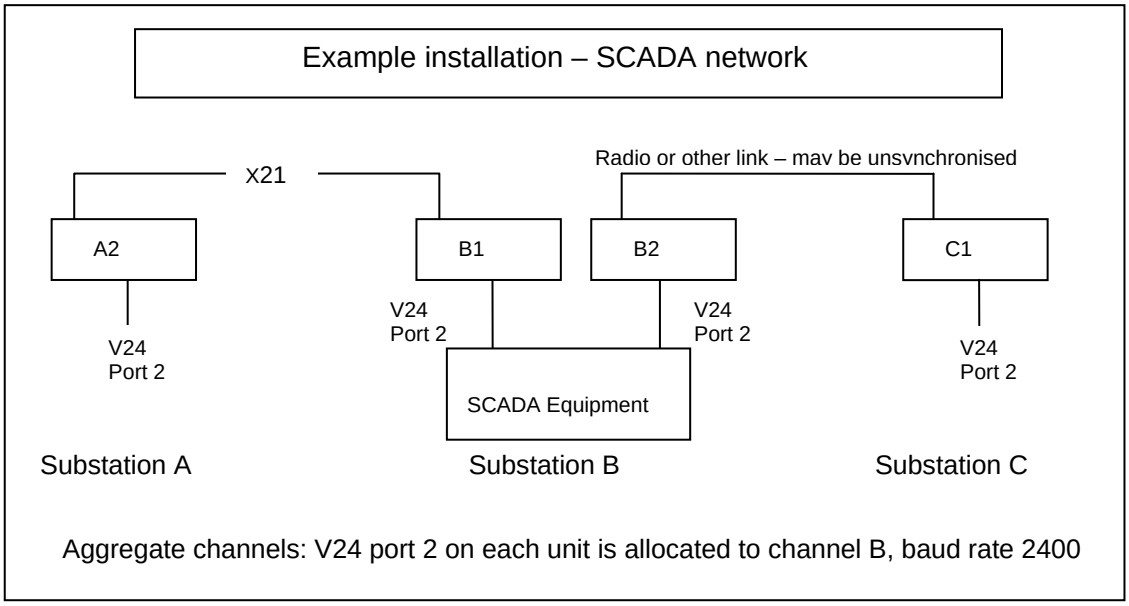
DIP switch settings for A2 and B1 as example 2, units A2 and B1 respectively

DIP Switch Settings for B2								
	8	7	6	5	4	3	2	1
SW1	*	*	*	*	*	*	*	*
SW2	0	1	0	1	1	0	0	1
SW3	*	*	*	*	*	*	*	*
SW4	*	*	*	*	*	*	*	*
SW5	0	0	1	1	0	0	0	0
SW6	0	0	0	1	*	*	1	*

* indicates setting not applicable to this setup

Example 5: Data Channel Concatenation
In this example, data on a single channel only is transferred from end to end, across unsynchronised X21 links.
Set Aggregate Direction for all units to X21 port. Transmit and Receive data is presented at all ports. Only possible on a well disciplined system where only on terminal transmits at once. This configuration allows both X21 links to run unsynchronised.

Each link runs at its own clock speed. The data is transferred from B1 to B2 at V24 level by effectively being re-transmitted from the SCADA equipment.



DIP Switch Settings for all units								
	8	7	6	5	4	3	2	1
SW1	*	*	*	*	*	*	*	*
SW2	0	1	0	0	1	0	0	1
SW3	*	*	*	*	*	*	*	*
SW4	*	*	*	*	*	*	*	*
SW5	0	0	0	0	0	0	0	1
SW6	0	0	0	0	*	*	1	*

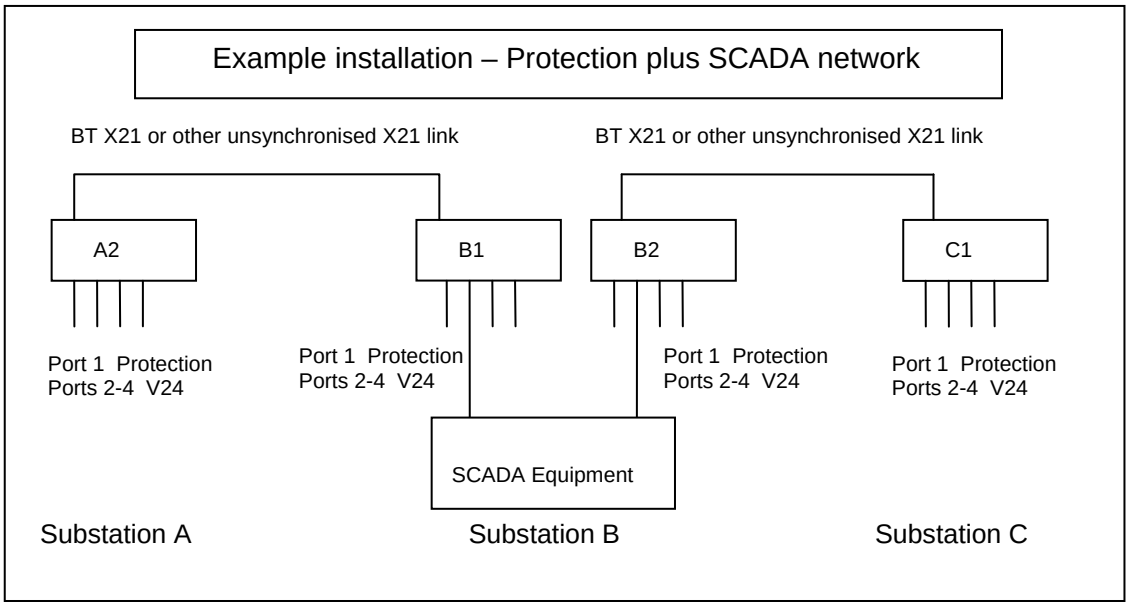
* indicates setting not applicable to this setup

If a Westica radio is to be used, these are configured as detailed in Section 7.6 Figure 7-1 of the Westica manual. Radio 1 is configured as Int Master (DCE), Radio 2 at C1 end is configured as Slave (DCE).
The Interconnection cable at each end is straight X21, as Cable Y in Example 3.

Example 6: Factory Configuration

In this configuration:
Port 1, channel A, protection circuit, transparent
Port 2, channel B, 2400 baud, 8 bit
Port 3, sharing channel B to provide additional V24 ports
Port 4, channel D, 2400 baud, 8 bit

Each link runs at its own clock speed. SCADA data may be transferred from B1 to B2 at V24 level by effectively being re-transmitted from the SCADA equipment. Only possible on a well disciplined system where only on terminal transmits at once.



DIP Switch Settings for all units								
	8	7	6	5	4	3	2	1
SW1	0	0	0	0	0	1	0	0
SW2	0	1	0	0	1	0	0	1
SW3	0	1	0	0	1	0	0	1
SW4	0	1	0	0	1	0	1	1
SW5	0	0	0	0	0	0	0	1
SW6	0	0	0	0	1	1	1	0

Blank setting table:

Location:								
Reference:								
DIP Switch Settings								
	8	7	6	5	4	3	2	1
SW1								
SW2								
SW3								
SW4								
SW5								
SW6								

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